DAVROC

File: L07-0474PT

C3 Environmental Limited
350 Wollwich Street South
Breslau, Ontario
N0B 1M0

October 20, 2008

Attn.: Mr. Minh Le, P.Eng.

Permeability Test Results
Grout Cylinder Samples
Bay Shore Project

Further to receipt of two (2) 100 mm diameter by 200 mm long Grout Cylinder specimens in our laboratory on July 28, 2008, Davroc Testing Laboratories Inc., are pleased to report the results of our Water Permeability Tests.

The cylinder specimens were identified as follows:

Davroc Lab No.	Cylinder No.	Date Cast
1198-1	1	July 24, 2008
1198-2	3	July 24, 2008

Test Method

As instructed, the cylinder specimens were tested for coefficient of permeability using the following test procedures:

1. Prior to testing, the cylinder samples were wet cured up to 28 days age under standard laboratory conditions (i.e. 23±2°C R/H 100%).

2. One (1) 50 mm thick slice was removed from each test cylinder.

3. The 50 mm thick slice was placed under a vacuum for three (3) hours. After this period of vacuum, distilled water was introduced into the vacuum chamber for one (1) hour.

4. Upon completion of the vacuuming procedure, the specimens were placed immediately into the CACA type water permeability cell.

5. The permeability test cell applies a solution of sodium chloride (NaCl) at a concentration of 19,000 ppm, at a pressure of 8 bar (116 psi) to the face of the specimen surface. The test was conducted at normal room temperature and pressure testing in the permeability cell continued for 40 days. Chlorides were used as a tracer. After 40 days under pressure the ingress of the chloride front was measured by grinding layers of concrete and determining the chloride profile. The resultant permeability coefficient was calculated using the modified Valenta equation.

6. The level of fluid in the outflow reservoir was also monitored through the testing procedures. Note that during the testing procedure, there was no measurable water outflow from each test specimen.

Test Results

Chloride Profiles

Upon completion of the 40 day period under 8 bar of pressure, the grout samples were removed from the permeability cell and chloride profiles were obtained. To obtain the chloride profile, layers of 1.59 mm thick (first layer was taken at 3.18 mm depth), were ground using a diamond grinding bit. Each layer was analyzed for total chlorides, and the results are presented in Table 1 below. Each horizon represents the mid-depth point of each layer, i.e. the first horizon is at 1.59 mm which is the layer thickness of 3.18 mm divided by 2. The background chloride content was determined and the depth of penetration of chloride was obtained for each sample. The depth of chloride penetration (x_d) is the "point at which the concentration reached the background" (Hart et al., High Performance Concrete in Precast Concrete Tunnel Linings)[1]. The depth of penetration for both Samples #1198-1 and #1198-3 was 22.23 mm.

Table 1: Chloride Profiles

	Total Chloride (% by Weight)	
Horizon (mm)	**Sample 1198-1**	**Sample 1198-3**
1.59	0.535	0.512
4.77	0.190	0.165
6.35	0.089	0.071
7.95	0.045	0.052
9.53	0.051	0.044
11.12	0.046	0.043
12.71	0.050	0.052
14.30	0.043	0.036
15.89	0.037	0.037
17.47	0.038	0.041
19.06	0.032	0.033
20.65	0.032	0.030
22.23	0.028	0.031
23.82	0.026	0.029
25.41	0.023	0.031
Average Background Chlorides	**0.027**	**0.030**

A graphical presentation of the above chloride profile test data is shown on the attached Graph No.'s 1 and 2.

Permeability Calculations

In order to determine the coefficient of water permeability, using chlorides as a tracer, a modified version of the Valenta equation is used (Wood et al., 1989)[2]:

$k = (n(x_d)^2)/(2th)$

where:

k	=	coefficient of water permeability (m/s)
n	=	porosity
x_d	=	depth of penetration calculated from chloride concentration profile(m)
t	=	time under pressure (s)
h	=	hydraulic head (m)

Parameters	Sample 1198-1	Samples 1198-3
n	0.1021	0.0988
x_d (m)	0.02223	0.02223
t (s)	3456000	3456000
h (m)	81.577	81.577
Coefficient of water permeability **k (m/s)**	**89.48×10^{-15}**	**86.59×10^{-15}**

Comments:

The grout had map cracking throughout which was visible immediately after cutting the samples. This visible cracking likely affected the results obtained.

We trust this provides you with the information you require at this time. should you require any further information, please do not hesitate to contact the undersigned should you have any questions.

Yours very truly,
Davroc Testing Laboratories Inc.

Sal Fasullo, C.E.T.
Vice President

References

(1) Hart, A.J.R., Ryell, J. and Thomas, M.D.A, "High Performance Concrete in Precast Concrete Tunnel Linings: Meeting Chloride Diffusion and Permeability Requirements".

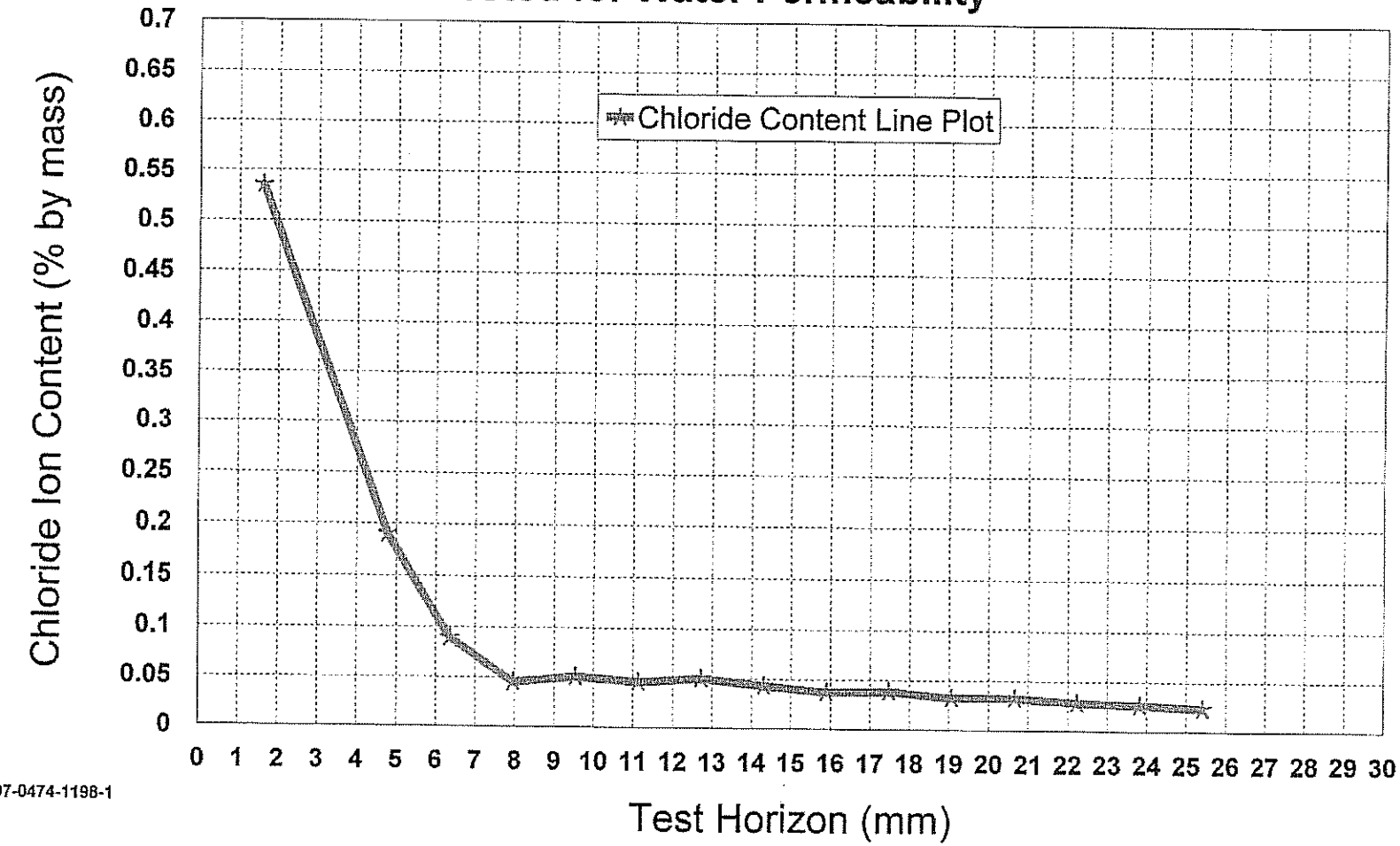
(2) Wood, J.G.M., Wilson, J.R. and Leek, D.S., "Improved Testing for Chloride Ingress Resistance of Concretes and Relation of Results to Calculated Behaviour", Bahrain Society of Engineers and CIRIA, 1989.

DAVROC

L07-0474Cl

October 20, 2008

Graph No. 1
C3 Environmental Limited
Grout Cylinder Sample No. 1198-1
Total Chloride Ion Profile Plot
Tested for Water Permeability



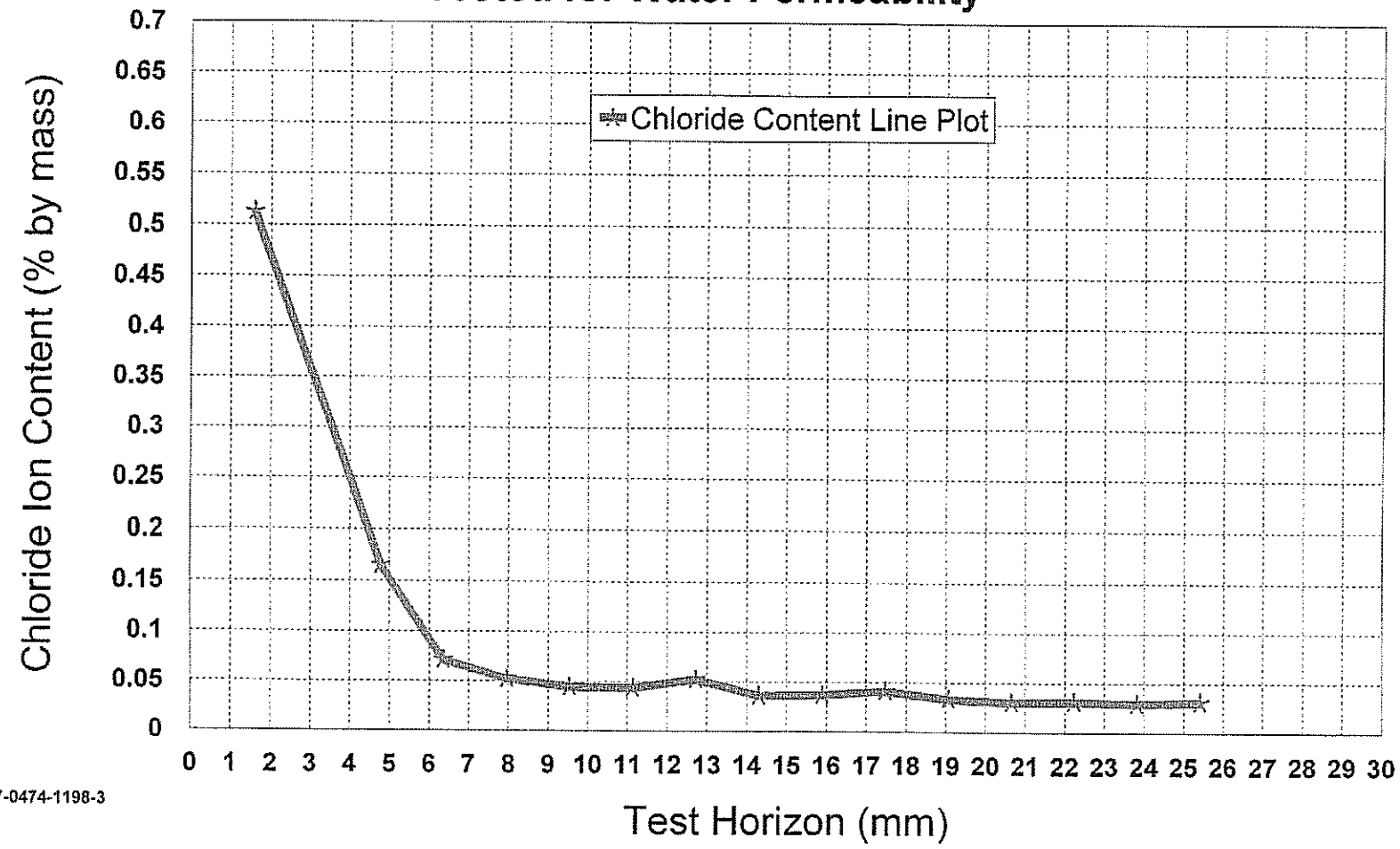
07-0474-1198-1

DAVROC

L07-0474CI

October 20, 2008

Graph No. 2
C3 Environmental Limited
Grout Cylinder Sample No. 1198-3
Total Chloride Ion Profile Plot
Tested for Water Permeability



07-0474-1198-3